SOME CONSIDERATIONS IN THE MAGNESIUM CYCLE OF WEATHERING IN SOLONETZ SOILS

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FRANK FREDERICK RIECKEN

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SOME CONSIDERATIONS IN THE MAGNESIUM CYCLE OF WEATHERING IN SOLONETZ SOILS

Numerous investigators have shown that the exchangeable base status of certain morphological solonetz soils is not in harmony with the theories proposed for their genesis. It has been further shown by a number of workers that a high ratio of the exchangeable magnesium to calcium of certain horizons is a feature of a number of morphological solonetz soils. Therefore, the present study was initiated in order to investigate the status of the exchangeable magnesium in certain of these soils of solonetz morphology.

In the first phase of the experimental work, the relative ease of release of exchangeable calcium and magnesium from natural soil systems was determined. The systems studied included samples from several dark brown solonetz, one chernozem solonetz, one degraded chernozem, and one dark brown zonal profile. The samples were from the B_1 horizon of these profiles. The solonetz and degraded chernozem samples had a high ratio of the replaceable magnesium to calcium. The replacing electrolytes used were NaCl, KCl, and NH_4Cl which were added in varying symmetry concentrations. The results of these experiments showed that a greater percentage of the exchangeable magnesium than calcium was released by the neutral replacing electrolytes. The relative amount of magnesium released, compared to the calcium released, was about 1.2 to 1.4. From the results obtained it is concluded that the exchangeable magnesium present in the soils examined was normal replaceable magnesium. This magnesium entered into exchange and release reactions in the same manner as the magnesium in Mg-clay systems which are prepared by adding MgO to H-clay.

The second phase of the experimental work dealt with the investigation of various reactions of magnesium ions with clay colloids. The relative ease of release of exchangeable calcium and magnesium from natural soil systems was determined for an alkaline replacing electrolyte. At about pH 8.2 to 8.5 the magnesium ions were more energetically adsorbed than the calcium ions. However, at pH values lower than these the calcium ions were more energetically adsorbed than the magnesium ions.

The effect of the pH on the adsorption of magnesium and calcium ions by clay colloids was studied by using a H-clay system to which increments of NaOH were added. At about pH 8.2-8.5 and above, the magnesium ions were more energetically adsorbed than the calcium ions by the Na-clay system.

An alkaline replacing electrolyte, NaOH- NaCl, was used to replace the exchangeable magnesium and calcium from a degraded chernozem sample. This experiment showed that the exchangeable magnesium was more energetically held than the calcium at a pH of about 8.7. However, at this pH the ion product of the magnesium ions in the supernatant liquid and the OH ions as determined from the pH value, was considerably lower than the K. s. p. value. But, if the concentration of the magnesium ions surrounding the clay particles as exchangeable ions, assuming a 20 percent H_2O content associated with the clay particle, was used in the calculation, the ion product was found to be about the value of the solubility product. Accordingly, the interpretation is that this exchangeable magnesium was being precipitated in close proximity to the clay particle. This $Mg(OH)_2$ may possibly have entered into reaction with the clay micelle. That this is a possibility is shown by the reduction in exchange capacity of montmorillonite when this clay mineral was wetted and dried in the presence of $MgCl_2$ and excess KOH. Presumably the $Mg(OH)_2$ was formed within the expanding lattice of the montmorillonite, and reacted with the negatively charged lattice.

The fact that increasing amounts of bases were adsorbed by clay as increments of alkali were added is explained by the increased exchange capacity of the clay in alkaline systems. It has been shown that the exchange capacity of finely ground muscovite was increased in alkaline suspension. Likewise, a soil colloid, wetted and dried in the presence of excess alkali, had an increased exchange capacity. The methtod of determining this induced capacity influenced the magnitude of the increase. This increased capacity was not very stable as it is reduced with acid treatment. It is suggested that this reaction may be of importance for clay formation in soils of neutral and calcareous reaction.

The weathering cycle of magnesium in soils of solonetz morphology was discussed from the following points: (1) that the exchangeable magnesium entered into exchange reactions in a normal manner, (2) that the exchangeable magnesium in the soils studied was more easily displaced than the calcium, and (3) that according to the investigations of other workers, there likely has been a trend in the solum for the total magnesium to increase relative to the total calcium as weathering and leaching of calcium and magnesium continue in the profile. Therefore, it is presumed that the status of the exchangeable bases in the illuvial horizon of the solonetz soils has been established because of the relationship existing between the relative additions of bases by the vegetation and mineral weathering to the exchange complex.

The vegetative growth is considered more luxuriant on the zonal profiles of the brown, dark brown and chernozem soils, than on the associated morphological solonetz soils. The ratio of exchangeable calcium and magnesium in these zonal profiles indicates that a larger concentration of calcium than magnesium ions has come into contact with the exchange complex of the soil.

In the morphological solonetz soils the ratio of the replaceable calcium to magnesium indicates that for the upper part of the A horizon more calcium than magnesium ions have come into contact with the exchange complex. However, for the B_1 horizon the Ca: Mg ratio indicates that a greater concentration of magnesium than calcium ions have come into contact with the exchange complex. The development of the claypan horizon in the morphological solenetz favors weathering of the layer above this horizon. The amounts of magnesium ion released in this intensely weathered layer, sometimes called the A_3 horizon, is presumably greater than the calcium supplied to the exchange complex by the vegetation and mineral weathering. It is surmised that it is due to these relationships that the exchangeable magnesium is present in greater amounts than the calcium in the B_1 horizon of many morphological solonetz soils. This relationship has, in all likelihood, a definate relationship to the return of bases by the vegetation to the solum. As the brown, dark

brown, and chernozem soils and their intrazonal associates have been developed in regions of limited rainfall, the annual base return is probably low compared to the prairie soils. Furthermore, in profiles with a strongly eluviated horizon, it is postulated that a sufficient concentration of magnesium ions has been released from minerals to favor a high saturation of the exchange complex with magnesium ions. There is a possibility that this phenomenon finds its chief occurrence in the semi-arid and sub-humid regions because of these relationships.

In many soils with solonetz morphology, the processes of soil development are apparently similar in many respects to the processes in the plansols of the humid regions. It is suggested, therefore, that many claypan soils of the brown, dark brown and chernozem zones could very appropriately be classified with the plansol group of soils. In this case the establishment of suitable sub-groups could be made to provide separate classes for the plansols developed in the pedocal and pedalfer regions.

VITA

The author was born the 4th of October, 1908, at Girvin, Saskatchewan, Canada. He attended Reber Grade School at Girvin, Saskatchewan, and received his high school eduction at the Lutheran High School and Theological Seminary, Saskatoon, Saskatchewan, graduating in 1925.

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